A Short Note on Nuclear Physics

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Commentary

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DESCRIPTION

Nuclear physics is the branch of physics that studies atomic nuclei, their constituents, and interactions, as well as other types of nuclear matter. Nuclear physics is not to be confused with atomic physics, which studies the atom in its entirety, including its electrons. Nuclear physics discoveries have led to applications in a wide range of fields. Nuclear power, nuclear weapons, nuclear medicine and magnetic resonance imaging, industrial and agricultural isotopes, ion implantation in materials engineering, and radiocarbon dating in geology and archaeology are all examples of this. These applications are being researched in the field of nuclear engineering. Radioactivity was extensively researched in the years that followed, particularly by Marie Curie, Pierre Curie, Ernest Rutherford, and others. By the turn of the century, physicists had also discovered three types of atomic radiation, which they named alpha, beta, and gamma radiation.

Otto Hahn's 1911 experiment and James Chadwick's 1914 experiment discovered that the beta decay spectrum was continuous rather than discrete. That is, rather than the discrete amounts of energy observed in gamma and alpha decays, electrons were ejected from the atom with a continuous range of energies. This presented a problem for nuclear physics at the time, as it appeared to indicate that energy was not conserved in these decays. Becquerel received the Nobel Prize in Physics in 1903, along with Marie and Pierre Curie for their subsequent research into radioactivity. In 1908, Rutherford received the Nobel Prize in Chemistry for his "investigations into the disintegration of elements and the chemistry of radioactive substances". Albert Einstein proposed the concept of mass–energy equivalence in 1905. While Becquerel and Marie Curie's work on radioactivity predates this, an explanation of the source of radioactivity's energy would have to wait until the discovery that the nucleus itself was made up of smaller constituents, the nucleons. Hundreds of nucleons can be found in a heavy nucleus. This means that it can be treated as a classical system, rather than a quantum-mechanical one, to some extent. In the resulting liquid-drop model, the nucleus has energy that is derived partly from surface tension and partly from proton electrical repulsion. Many features of nuclei can be reproduced by the liquid-drop model, including the general trend of binding energy with respect to mass number and the phenomenon of nuclear fission. However, quantum-mechanical effects are superimposed on this classical picture, which can be described using the nuclear shell model, which was developed in large part by Maria Goeppert Mayer and J. Hans D. Jensen. Much of today's nuclear physics research is concerned with the study of nuclei under extreme conditions such as high spin and excitation energy. Nuclei can also have unusual shapes (similar to rugby balls or even pears) or unusual neutron-to-proton ratios. Experimenters can generate such nuclei by using ion beams from an accelerator to induce fusion or nucleon transfer reactions. Beams with even higher energies can be used to generate nuclei at extremely high temperatures, and there are indications that these experiments have resulted in a phase transition from normal nuclear matter to a new state, the quark–gluon plasma, in which the quarks mingle with one another rather than being segregated in triplets as they are in neutrons and protons.